CHAPTER II - RECONNAISSANCE AND FIXES

1. GENERAL

The Joint Typhoon Warning Center depends on reconnaissance to provide necessary, accurate, and timely meteorological information in support of each warning. JTWC relies primarily on three reconnaissance platforms: aircraft, satellite, and radar. In data rich areas synoptic data are also used to supplement the above. Optimum utilization of all available reconnaissance resources is obtained through the Selective Reconnaissance Program (SRP); various factors are considered in selecting a specific reconnaissance platform including capabilities and limitations, and the tropical cyclone's threat to life/property afloat and ashore. A summary of reconnaissance fixes received during 1982 is included in Section 6 of this Chapter.

2. RECONNAISSANCE AVAILABILITY

a. Aircraft

Aircraft weather reconnaissance in the JTWC area of responsibility is performed by the 54th Weather Reconnaissance Squadron (54th WRS) located at Andersen Air Force Base, Guam. The 54th WRS is presently equipped with six WC-130 aircraft and, from July through October, is augmented by the 53rd WRS from Keesler Air Force Base, Mississippi, bringing the total number of available aircraft to nine. The JTWC reconnaissance requirements, provided daily throughout the year to the Tropical Cyclone Aircraft Reconnaissance Coordinator (TCARC), include system(s) to be fixed, fix times, and forecast positions for each fix. The following priorities are utilized in acquiring meteorological data from reconnaissance aircraft in the western North Pacific area in accordance with CINCPACINST 3140.1 (series):

(1) Investigative flights and vortex or center fixes.

(2) Synoptic data acquisition in support of tropical cyclone warnings.

(3) Supplementary fixes on tropical cyclones.

As in previous years, aircraft reconnaissance provided direct measurements of height, temperature, flight-level winds, sea level pressure, estimated surface wind (when observable), and numerous additional parameters. The meteorological data are gathered by the Aerial Reconnaissance Weather Officers (ARWO) and dropsonde operators of Detachment 4, Hq AWS, who fly with the 54th WRS. These data provide the Typhoon Duty Officer (TDO) with indications of changing tropical cyclone characteristics, radii of associated winds, and current tropical cyclone position and intensity. Another important aspect is the availability of the data for research on tropical cyclone analysis and forecasting.

b. Satellite

Satellite fixes from USAF/USN ground sites and USN ships provide day and night coverage in the JTWC area of responsibility. Interpretation of this satellite imagery provides tropical cyclone positions and estimates of current and forecast intensities through the Dvorak technique (for daytime passes).

c. Radar

Land radar provides positioning data on well developed tropical cyclones when in the proximity (usually within 175 nm (324 km)) of the radar sites in the Philippines, Taiwan, Hong Kong, Japan, South Korea, Kwajalein, and Guam.

d. Synoptic

In 1982 JTWC also determined tropical cyclone positions based on the analysis of the surface/gradient level synoptic data. These positions were helpful in situations where the vertical structure of the tropical cyclone was weak or accurate surface positions from aircraft were not available due to flight restrictions.

3. AIRCRAFT RECONNAISSANCE SUMMARY

During the 1982 tropical season, the JTWC levied 276 vortex fixes and 50 investigative missions of which 17 were flown into disturbances which did not develop. In addition to the levied fixes, 180 supplemental fixes were also obtained. The average vector error for all aircraft fixes received at the JTWC during 1982 was 11 nm (20 km).

Aircraft reconnaissance effectiveness is summarized in Table 2-1 using the criteria as set forth in CINCPACINST 3140.1 (series).

TABLE 2-1. AIRCRAFT RECONNAISSANCE EFFECTIVENESS

EFFECTIVENESS	NUMBER OF LEVIED FIXES	PERCENT
COMPLETED ON TIME	239	86.5
EARLY	6	2.2
LATE	14	5.1
MISSED	17	6.2
TOTAL	276	100.0

LEVIED VS. MISSED FIXES

	LEVIED	MISSED	PERCENT
AVERAGE 1965-1970	507	10	2.0
1971	802	61	7.6
1972	624	126	20.2
1973	227	13	5.7
1974	358	30	8.4
1975	217	7	3.2
1976	317	11	3.5
1977	203	3	1.5
1978	290	2	0.7
1979	289	14	4.8
1980	213	4	1.9
1981	201	3	1.5
1982	276	17	6.2

4. SATELLITE RECONNAISSANCE SUMMARY

The Air Force provides satellite reconnaissance support to JTWC using imagery from a variety of spacecraft. The tropical cyclone satellite surveillance network consists of both tactical and centralized facilities. Tactical DMSP sites are located at Nimitz Hill, Guam; Clark AB, Republic of the Philippines; Kadena AB, Japan; Osan AB, Korea; and Hickam AFB, Hawaii. These sites provide a combined coverage that includes most of the JTWC area of responsibility in the western North Pacific from near the dateline westward to the Malay Peninsula. The Naval Oceanography Command Detachment, Diego Garcia, provides NOAA polar-orbiting coverage in the central South Indian Ocean; this reconnaissance supplements the Air Force Global Weather Central (AFGWC) support in this data sparse region.

AFGWC, located at Offutt AFB, Nebraska, is the centralized member of the tropical cyclone satellite surveillance network. In support to JTWC, AFGWC processes imagery from DMSP and NOAA spacecraft. Imagery processed at AFGWC is recorded on-board the spacecraft as it passes over the earth. Later, these data are downlinked to AFGWC via a network of command/readout sites and communications satellites. This enables AFGWC to obtain the coverage necessary to fix all tropical systems of interest to JTWC. AFGWC has the primary responsibility to provide tropical cyclone surveillance over the entire Indian Ocean and portions of the western North Pacific on both sides of the dateline. Additionally, AFGWC can be tasked to provide tropical cyclone positions in the western North Pacific and South Pacific as backup to coverage routinely available in those regions.

The hub of the network is Det 1, 1WW, colocated with JTWC on Nimitz Hill, Guam. Based on available satellite coverage, Det 1 coordinates satellite reconnaissance requirements with JTWC and tasks the individual network sites for the necessary tropical cyclone fixes. Therefore, when a position from a polar-orbiting satellite is required as the basis for a warning, called a "levied fix", a dual-site tasking concept is applied. Under this concept, two sites are tasked to fix the tropical cyclone from the same satellite pass. This provides the necessary redundancy to virtually guarantee JTWC a successful satellite fix on the tropical cyclone. Using this dual-site concept, the satellite reconnaissance network is capable of meeting all of JTWC's levied satellite fix requirements. Dual-site tasking can also be applied in portions of the North Indian Ocean by tasking AFGWC and the Navy site at Diego Garcia.

The network provides JTWC with several products and services. The main service is one of surveillance. Each site reviews its daily satellite coverage for indications of tropical cyclone development. If an area exhibits the potential for development, JTWC is notified. Once JTWC issues either a formation alert or warning, the network is tasked to provide three products: tropical cyclone positions, intensity estimates, and 24-hour intensity forecasts. Satellite tropical cyclone positions are assigned position code numbers (PCN) depending on the availability of geography for precise gridding and the degree of organization of the tropical cyclone's circulation center (Table 2-2). During 1982, the network provided JTWC with a total of 2026 satellite fixes on tropical systems in the western North Pacific. Another 146 were made for tropical systems in the North Indian Ocean. A comparison of those fixes made on numbered tropical cyclones in the western North Pacific with their corresponding JTWC best track positions is shown in Table 2-3. Estimates of the tropical cyclone's current intensity and a 24-hour intensity forecast are made once each day by applying the Dvorak technique (NOAA Technical Memorandum NESS 45 as revised) to daylight visual data.

The availability of polar-orbiting meteorological satellites declined again in 1982, after an improvement in 1981. At the beginning of 1982, there were three polar-orbiting satellites available; F-3 (FTV 14537) with limited coverage and availability, and NOAA 6 and 7 which were functioning normally. In February, NOAA 6 developed scanning problems and provided very little imagery data except for brief periods through most of the 1982 season. In November, the problem was corrected and NOAA 6 began functioning normally once again. NOAA 7, with nearly 8,000 orbits at the end of 1982, provided excellent data throughout the year and served as the network's primary reconnaissance satellite. A DMSP spacecraft, F-6 (FTV 17540), was launched on 20 December and is expected to be operational in January, 1983. F-6 replaces F-3 and may become the network's primary reconnaissance satellite in 1983. The outlook for 1983 looks even better, with projected launches of NOAA-E in February and F-7 in the latter part of the year.

TABLE 2-2. POSITION CODE NUMBERS

PCN	METHOD OF CENTER DETERMINATION/GRIDDING
1	EYE/GEOGRAPHY
2	EYE/EPHEMERIS
3	WELL DEFINED CC/GEOGRAPHY
4	WELL DEFINED CC/EPHEMERIS
5	POORLY DEFINED CC/GEOGRAPHY
6	POORLY DEFINED CC/EPHEMERIS

CC = Circulation Center

TABLE 2-3. MEAN DEVIATION (NM) OF ALL SATELLITE DERIVED TROPICAL CYCLONE POSITIONS FROM THE JTWC BEST TRACK POSITIONS. NUMBER OF CASES (IN PARENTHESES).

	WESTERN NORTH PACIFIC OCEAN		NORTH INDIAN OCEAN	
	1974-1981 AVERAGE	1982	1980-1981 AVERAGE	1982
PCN	(ALL SITES)	(ALL SITES)	(ALL SITES)	(ALL SITES)
1	13.7 (428)	12.9 (109)	17.0 (9)	15.4 (18)
2	17.9 (85)	11.5 (291)	9.5 (2)	8.5 (2)
3	19.5 (652)	16.8 (113)	29.7 (6)	15.8 (3)
4	24.4 (120)	15.7 (293)	(0)	19.1 (3)
5	36.6 (1514)	32.3 (325)	32.0 (22)	33.3 (43)
6	44.1 (317)	32.8 (732)	37.0 (33)	33.6 (31)
1&2	14.4 (513)	11.9 (400)	15.6 (11)	14.7 (20)
3&4	20.4 (772)	16.0 (406)	29.7 (6)	17.5 (6)
5&6	37.9 (1831)	32.6 (1057)	35.0 (55)	33.4 (74)

Besides fixes from the network, JTWC also received satellite-derived tropical cyclone positions from several secondary sources during 1982. These included: U.S. Navy ships equipped for direct readout; the National Environmental Satellite Service (NESS) using NOAA and GOES data; and the Naval Polar Oceanography Center, Suitland, Maryland using stored DMSP and NOAA data. Fixes from these secondary sources are not included in the network statistics.

5. RADAR RECONNAISSANCE SUMMARY

Eighteen of the 28 significant tropical cyclones occurring over the western North Pacific during 1982 passed within range of land based radars with sufficient cloud pattern organization to be fixed. The hourly and oftentimes, half-hourly land radar fixes that were obtained and transmitted to JTWC totaled 475.

The WMO radar code defines three categories of accuracy: good (within 10 km (5 nm)), fair (within 10 to 30 km (5 to 16 nm)), and poor (within 30 to 50 km (16 to 23 nm)). This year, 475 radar fixes were coded in this manner; 243 were good, 145 fair, and 87 poor. Compared to the JTWC best track, the mean vector deviation for land radar sites was 16 nm (30 km). Excellent support through timely and accurate radar fix positioning allowed JTWC to track and forecast tropical cyclone movement through even the most difficult and erratic tracks.

No radar fixes were made by reconnaissance aircraft during the 1982 tropical cyclone season in the western North Pacific area and, as in previous years, no radar reports were received on North Indian Ocean tropical cyclones.

6. TROPICAL CYCLONE FIX DATA

A total of 2970 fixes on 28 western North Pacific tropical cyclones and 127 fixes on five North Indian Ocean tropical cyclones were received at JTWC. Table 2-4, Fix Platform Summary, delineates the number of fixes per platform for each individual tropical cyclone. Season totals and percentages are also indicated.

Annex A includes individual fix data for each tropical cyclone. Fix data are divided into four categories: Satellite, Aircraft, Radar, and Synoptic. Those fixes labelled with an asterisk (*) were determined to be unrepresentative of the surface center and were not used in determining the best tracks. Within each category, the first three columns are as follows:

FIX NO. - Sequential fix number

TIME (Z) - GMT time in day, hours and minutes

FIX POSITION - Latitude and longitude to the nearest tenth of a degree

Depending upon the category, the remainder of the format varies as follows:

a. Satellite

(1) ACCRY - Position Code Number (PCN) is used to indicate the accuracy of the fix positon. A "1" indicates relatively high accuracy and a "6" relatively low accuracy.

(2) DVORAK CODE - Intensity evaluation and trend utilizing visual satellite data (Figure 2-1, Table 2-5). (For specifics, refer to NOAA TM; NESS-45)

(3) COMMENTS - For explanation of abbreviations, see Appendix I.

(4) SITE - ICAO call sign of the specific satellite tracking station.

b. Aircraft

(1) FLT LVL - The constant pressure surface level, in millibars or altitude, in feet, maintained during the penetration. The normal level flown in developed tropical cyclones, due to turbulence factors, is 700 mb. Low-level missions are normally flown at 1500 ft (457 m).

(2) 700 MB HGT - Minimum height of the 700 mb pressure surface within the vortex recorded in meters.

TABLE 2-4. FIX PLATFORM SUMMARY FOR 1982

FIX PLATFORM SUMMARY

WESTERN NORTH PACIFIC	AIRCRAFT	SATELLITE	RADAR	SYNOPTIC	TOTAL
TS MAMIE	7	68	3	--	78
TY NELSON	25	105	11	--	141
TY ODESSA	15	55	--	--	70
TY PAT	16	52	6	1	75
TY RUBY	15	63	--	--	78
TS TESS	--	40	--	8	48
TS SKIP	4	25	--	1	30
TS VAL	2	14	--	4	20
TS WINONA	16	86	92	3	197
TY ANDY	11	72	14	--	97
STY BESS	30	101	4	4	139
TY CECIL	16	82	38	7	143
TY DOT	23	66	3	2	94
TY ELLIS	24	87	64	3	178
TY FAYE	27	133	41	3	204
TY GORDON	36	90	--	--	126
TS HOPE	1	26	2	4	33
TY IRVING	13	109	59	7	188
TY JUDY	26	68	10	5	109
TY KEN	33	84	32	3	152
TS LOLA	--	28	--	--	28
TD 22	2	10	--	--	12
STY MAC	32	73	35	--	140
TY NANCY	19	80	14	2	115
TD 25	1	15	--	--	16
TY OWEN	27	128	--	--	155
TY PAMELA	44	160	22	3	229
TY ROGER	3	44	25	3	75
TOTAL	468	1964	475	63	2970
% OF TOTAL NR OF FIXES	15.8	66.1	16.0	2.1	100.0

INDIAN OCEAN	SATELLITE	SYNOPTIC	TOTAL
TC 20-82	46	--	46
TC 22-82	31	--	31
TC 23-82	29	--	29
TC 24-82	6	1	7
TC 25-82	10	4	14
TOTAL	122	5	127
% OF TOTAL NR OF FIXES	96.1	3.9	100.0

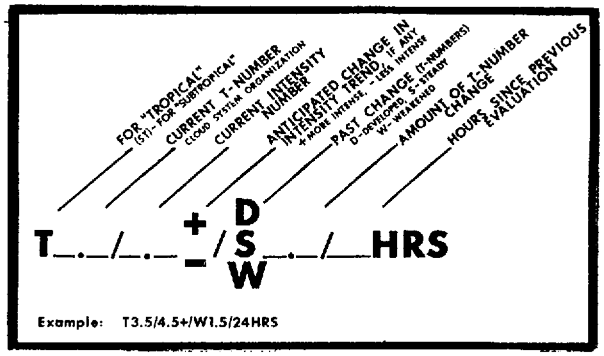

Figure 2-1. The current T-number is 3.5 but the current intensity estimate is 4.5 (equivalent to 77 kt). The cloud system has weakened by 1.5 T-numbers since the previous evaluation conducted 24 hours earlier. The plus (+) symbol indicates an expected reversal of the weakening trend or very little further weakening of the tropical cyclone during the next 24-hour period.

TABLE 2-5. MAXIMUM SUSTAINED WIND SPEED (KT) AS A FUNCTION OF DVORAK CI & FI (CURRENT & FORECAST INTENSITY) NUMBER AND MINIMUM SEA LEVEL PRESSURE (MSLP)

TROPICAL CYCLONE INTENSITY NUMBER	WIND SPEED	MSLP (NW PACIFIC)
1.0	25	--
1.5	25	--
2.0	30	1003
2.5	35	999
3.0	45	994
3.5	55	988
4.0	65	981
4.5	77	973
5.0	90	964
5.5	102	954
6.0	115	942
6.5	127	929
7.0	140	915
7.5	155	900
8.0	170	884

(3) OBS MSLP - If the surface center can be visually detected (e.g., in the eye), the minimum sea level pressure is obtained by a dropsonde released above the surface vortex center. If the fix is made at the 1500-foot level, the sea level pressure is extrapolated from that level.

(4) MAX-SFC-WND - The maximum surface wind (knots) is an estimate made by the ARWO based on sea state. This observation is limited to the region of the flight path and may not be representative of the entire tropical cyclone. Availability of data is also dependent upon the absence of undercast conditions and the presence of adequate illumination. The positions of the maximum flight level wind and the maximum observed surface wind do not necessarily coincide.

(5) MAX-FLT-LVL-WND - Wind speed (knots) at flight level is measured by the AN/APN 147 doppler radar system aboard the WC-130 aircraft. Values entered in this category represent the maximum wind measured prior to obtaining a scheduled fix. This measurement may not represent the maximum flight level wind associated with the tropical cyclone because the aircraft only samples those portions of the tropical cyclone along the flight path. In many instances, the flight path is through the weak sector of the tropical cyclone. In areas of heavy rainfall, the doppler radar may track energy reflected from precipitation rather than from the sea surface, thus, preventing accurate wind speed measurement. In obvious cases, such erroneous wind data will not be reported. In addition, the doppler radar systen on the WC-130 restricts wind measurements to drift angles less than or equal to 27 degrees if the wind is normal (perpendicular) to the aircraft heading.

(6) ACCRY - Fix position accuracy. Both navigational (OMEGA and LORAN) and meteorological (by the ARWO) estimates are given in nautical miles.

(7) EYE SHAPE - Geometrical representation of the eye based on the aircraft radar presentation. The eye shape is reported only if the center is 50 percent or more surrounded by wall cloud.

(8) EYE DIAM/ORIENTATION - Diameter of the eye in nautical miles. When an elliptical eye is present, the lengths of the major and minor axes and the orientation of the major axis are respectively listed. When concentric eye walls are present, each diameter is listed.

c. Radar

(1) RADAR - Specific type of platform (land, aircraft, or ship) utilized for fix.

(2) ACCRY - Accuracy of fix position (good, fair, or poor) as given in the WMO ground radar weather observation code (FM20-V).

(3) EYE SHAPE - Geometrical representation of the eye given in plain language (circular, elliptical, etc.).

(4) EYE DIAM - Diameter of eye given in kilometers.

(5) RADOB CODE - Taken directly from WMO ground weather radar observation code FM20-V. The first group specifies the vortex parameters, while the second group describes the movement of the vortex center.

(6) RADAR POSITION - Latitude and longitude of tracking station given in tenths of a degree.

(7) SITE - WMO station number of the specific tracking station.